

3/23/17 "The two most powerful warriors are patience and time." -Leo Tolstoy

HW: "Solving Exponential Equations Using Logs" homework section  
Test 3 on Thursday 3/30

AIM: How do we solve Exponential Equations using Logs?

Warm Up:

1) The expression  $\log_4(\overbrace{x^2 - 16}^{\text{top}}) - \log_4(\underline{x + 4})$ , assuming  $x \neq 4$ , can be simplified to

(a)  $2\log_4 x - 12$

(b)  $\log_4(x - 4)$

$$\log_4 \frac{x^2 - 16}{x + 4} = \log_4 \frac{\cancel{(x + 4)}(x - 4)}{\cancel{x + 4}}$$

(c)  $\log_4(x + 4)$

(d)  $\log_4 x - 1$

### THE THIRD LOGARITHM LAW

$$\log_b(a^x) = x \log_b a$$

**Exercise #1:** Solve:  $4^x = 8$  using (a) common bases and (b) the logarithm law shown above.

(a) Method of Common Bases

$$\begin{aligned} 4^x &= 8 \\ (2^2)^x &= 2^3 \\ 2^{2x} &= 2^3 \\ 2x &= 3 \\ x &= \frac{3}{2} = 1.5 \end{aligned}$$

(b) Logarithm Approach

$$\begin{aligned} 4^x &= 8 \\ \log 4^x &= \log 8 \\ x \cdot \log 4 &= \log 8 \\ \frac{x \cdot \log 4}{\log 4} &= \frac{\log 8}{\log 4} \\ x &= \frac{\log 8}{\log 4} \\ x &= 1.5 \end{aligned}$$

c) Calculator

$$\begin{aligned} 4^x &= 8 \\ \text{Rewrite in} \\ \text{Log form:} \\ x &= \log_4 8 \\ x &= 1.5 \end{aligned}$$

**Exercise #2:** Solve each of the following equations for the value of  $x$ . Round your answers to the nearest hundredth. (2 decimals)

(a)  $5^x = 18$

$$\log 5^x = \log 18$$

$$x \log 5 = \log 18$$

$$x = \frac{\log 18}{\log 5}$$

$$x = 1.80$$

(b)  $4^x = 100$

$$x = \log_4 100$$

$$x = 3.32$$

(c)  $2^x = 1560$

$$\log 2^x = \log 1560$$

$$x \log 2 = \log 1560$$

$$x = \frac{\log 1560}{\log 2}$$

$$x = 10.61$$

**Exercise #3:** Solve each of the following equations for  $x$ . Round your answers to the nearest hundredth.

(a)  $6^{x+3} = 50$

$$x+3 = \log_6 50$$

$$x = (\log_6 50) - 3$$

$$x \approx -0.82$$

(b)  $(1.03)^{\frac{x}{2}-5} = 2$

$$\log \left( \frac{x}{2} - 5 \right) = \log 2$$

$$\left( \frac{x}{2} - 5 \right) (\log 1.03) = \log 2$$

$$\frac{x}{2} - 5 = \frac{\log 2}{\log 1.03}$$

$$\frac{x}{2} = \left( \frac{\log 2}{\log 1.03} + 5 \right) (2)$$

$$x = \left( \frac{\log 2}{\log 1.03} + 5 \right) (2)$$

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$$\left( \frac{\log(2)}{\log(1.03)} + 5 \right) * 2$$

56.8995445

$$x \approx 56.90$$

**Exercise #4:** Find the solution to each of the following exponential equations in terms of a logarithm with the same base as the exponential equation.

(a)  $4(2)^x - 3 = 17$

$$\frac{4(2)^x}{4} = \frac{20}{4}$$

$$2^x = 5$$

$$x = \log_2 5$$

(b)  $\frac{17(5)^{\frac{x}{3}}}{17} = \frac{4}{17}$

$$5^{\frac{x}{3}} = \frac{4}{17}$$

$$\log 5^{\frac{x}{3}} = \log \frac{4}{17}$$

$$\frac{x}{3} \cdot \log 5 = \frac{\log \frac{4}{17}}{\log 5}$$

$$\cancel{3} \cdot \frac{x}{\cancel{3}} = \left( \frac{\log \frac{4}{17}}{\log 5} \right) \cancel{3}$$

$$x = \left( \frac{\log \frac{4}{17}}{\log 5} \right) \left( \frac{3}{1} \right)$$

$$x = \frac{3 \log \frac{4}{17}}{\log 5}$$